AN APPARATUS FOR PHYSICAL EXERCISE, AND A CRANK DEVICE AND FOOT SUPPORTING PLATFORMS FOR USE WITH SUCH APPARATUS

Field of the invention

The present invention relates to an apparatus for physical exercise, and a crank device and foot supporting platforms for use with such apparatus, as defined in the introductory part of the attached independent claims. The invention is useful to provide for a choice among a plurality of different workout options related to simulation of movements, and to provide means for adjustment thereof according to user defined options.

Background of the invention

The benefits of regular aerobic exercise are well established and accepted. Because the major population in the western world live close together in towns and cities, far from the countryside and because of inclement weather, time constraints and for other reasons, it is not always possible to walk, jog, run or ski outdoors. Various types of indoor exercise equipment have been developed for aerobic exercise and to exercise leg muscles commonly used in walking, running, skiing, and other outdoors activities. Such apparatus include treadmills, stepping machines, and various types of sliding machines. Although effective to some extent, they all have disadvantages. Treadmills have the drawback of producing high impact on the user's hips, back, legs and knees. One approach that minimizes the tear on joints is to use a stair stepper. Stair steppers, however, do not develop all of the muscles commonly used in running. Furthermore, such machines are difficult to use in sprint type exercises. Finally, apparatus of the sliding type require the user to slide his/her feet back and forth along a horizontal plane. Such movement does not mimic running and thus offers exercise only to a limited range of muscles.

Combining these kinds of apparatus with an indoor training bicycle one would hope to have a variety of training options for aerobic exercise. This however would require a lot of floor space. To give a maximum aerobic exercise, combined with a simulation of

walking, jogging and running without straining the users joints and to save floor space, there has for long been a need to provide an improved range of a new type of training apparatus often denoted as elliptical trainers or cross trainers.

There is thus a great demand for training equipment capable of simulating a movement of the legs and feet, as they naturally would move when walking, jogging, running, skiing, climbing or performing a range of stepping motions.
A single apparatus capable of providing to highly satisfactory degree exercise assistance to such large variety of simulated movements is yet to be found on the market.

On the market today there is however available some exercise equipment of elliptical or cross trainer type aiming to provide such assistance, although so with more or less success. Worth mentioning as examples are products from Tunturi, LifeFitness, Icon and Precor. The aim of these trainers is to achieve an elliptical like orbit of user's feet during a workout similar to that commonly encountered during walking or running. Since the user's feet never leave the foot rails, minimal impact is produced. Training apparatus creating an orbit to pedals or platforms in an elliptical shape, are more than often built quite big to the required stride length. They also often have big crank wheels and many bars linked to each other and such trainers have limited means for adjustment of stride length and orbit of the pedals or platforms.

The present invention thus intends to solve inherent shortcomings of currently available exercise apparatus, and the present invention therefore intends to provide various embodiments of a single multifunctional piece of equipment or exercise apparatus which may be utilised to assist simulation of different exercises, including walking, jogging, running, skiing and climbing without imparting shock to the user's body joints in the manner of exercise treadmills. The inventive apparatus replaces treadmills, all types of steppers, elliptic operation type of apparatus, cross trainers, skiing exercise apparatus and various types of indoors training bikes.

Another aspect of the invention is strengthening of the joints and more specifically the muscles and tendons. Training during instability, also called proprioseptive training, has

shown positive effects strengthening the muscles round joints. A medical study using unstable pedals during training proves significant results. Such pedals are shown in publication WO00/68067 assigned Flexiped AS. The medical test mentioned was published in Scandinavian Journal of Medicine and Science in Sports, Vol. 13, issue 4, August 2003, author: Dr. Per Høiness. The present invention offers inclusion of elements of instability, specifically regarding supporting means for the feet. The feet supports will optionally be able to tilt transversely of the path of motion, and in addition have the ability to tilt parallel to the path of motion, to give a toe-heel movement.

Producing circular, elliptical and linear motions using two wheels, which interact and have the ratio of 2:1 is known already from the Renaissance when G. Cardano invented this concept and today often referred to as cardanic motion.

This concept is further explained in the publication "Method of synthesis of cardanic motion" by Aleksander Sekulic` published no later than 12.01.1998. This concept is utilized in different crank solutions mostly for bicycles but also described as a method in combustion engines. (See for example principle at www.flying-pig.co.uk/mechanism)

However, contrary to versatility of the apparatus of the present invention, neither of the mentioned prior art devices, nor other prior art devices are capable of achieving an optimal elliptical movement with means for easily adjustments of the path and motion in the way the present invention provides, and through use of an elected embodiment of exercise apparatus according to the invention being able to provide the great variety of assistance to simulated movements required for efficient and correct and optimal physical training, exercise or therapy.

In a preferred embodiment of the invention it is intended to provide an exercise apparatus with assisting handles for arm movement and for assisting in simulating a range of stepping motions, including walking, jogging, running, climbing and skiing, and with means for manually or automatically adjusting motions from a linear to elliptical path or elliptical like path to the footrest for user's feet.

Objects of the invention

It is thus an object of the present invention to provide improved exercise apparatus that provides for a plurality of motions ranging from linear to elliptical or elliptical like foot movement similar to that of walking, jogging, running, climbing and skiing.

Another object of the present invention is to provide the above exercising apparatus with means for producing any desired path or movement wanted by the user, and more specifically provide for selective adjustment to match e.g. stride of the user, size of orbit and the type of exercise chosen, preferably with automatically means.

Yet another object of the present invention is to provide a controlled posture and angle of the feet supports related to the exercise apparatus to match the stride and any movement required by the user.

Yet a further object of the present invention is to provide tilting of feet supports being operative on the exercise apparatus to create a degree of instability, which imposes challenges to the muscles and balance of the user.

Still another object of the present invention is to provide an exercise apparatus, which requires minimal space to operate and store, yet is still easy to operate, simple and reliable in operation and maintenance, and provides a cost-efficient piece of exercise apparatus capable of providing a greater variety of modes of use in a single piece of equipment compared with prior art devices.

Further, the present invention also aims at providing a crank device useful for the exercise apparatus and which provides for a greater range of modes of use, and is capable of contributing to the versatility previous unknown to a single piece of apparatus for physical exercise.

Brief summary of the invention

The invention utilises cardanic motion for producing a plurality of motions in a training or exercise apparatus. The motions are provided by a crank mechanism utilising cardanic motion which on each side of an axle has a disc, sprocket, cog or gear, here referred to as a sun gear, which is fixed relative to a second gear of half the size which revolves around the sun gear. The second gear is rotationally fixed on a crank arm, with an axle rotationally running through the sun gear. The rotational motion of the second gear is produced through a linkage to the sun gear, the linkage being gears, belts, chains or other mechanical transmission means. To the second gear is fixed a second crank arm, which has foot-supporting means. The foot supports in a preferred embodiment have means for controlling stability and angle relative to the motion.

The training apparatus according to the invention has mechanical means for adjusting a length of the crank arms, e.g. through use of motors and gears. The length of the crank arm decides the size and shape of the orbit and is preferably automatically adjustable dependent on speed or desired stride length. The orientation of the inventive crank system may be adjustable rotated in order to change the inclination of the path and motion, the rotation of the system preferably assisted by a motor. There are linkages between the fixed gear, the sun gear, preferably through use of gears, and the foot supporting means for stabilising and keeping a correct angle relative to an apparatus frame during a full rotation. The foot supporting means have also means for adjusting the angle to create a toe-heel tilt. The foot supporting means in form of platforms have optional tilt movement with an adjustable mechanism, the movement transverse the stepping motion, for utilising proprioceptive training and exercise.

In a further aspect of the present invention, a flywheel is mounted on a portion of the frame connected so to rotate as result of the crank movements. The flywheel serves as a momentum-storing device to simulate the momentum of the body during various stepping motions. Resistance may be applied to the rotation of the flywheel, to make the motion harder or easier to achieve. This resistance may be co-ordinated with the

workout level desired by the user. Similar kind of system is found on training/exercise apparatus, such as ergo-meter bikes, spinning bikes, cross trainers and the like.

The exercise apparatus would in a preferred embodiment include handlebars, which move as part of a training exercise. The handle bars would be pivotally fixed to a forward part of the training apparatus and hinged to bars linked to rotational parts of the crank mechanism in such a way that the bars move in an opposite direction relative to the feet supports giving a full cardiovascular workout.

Finally the exercise apparatus includes a user input, monitoring and control device, hereinafter referred to as a man machine interface device (MMI) which allows the user to adjust the machine so to achieve desired motion, speed, resistance and path, it being walking, jogging, running, climbing or skiing. The MMI device is preferably of a touch-screen type but could also be a combination of a display/screen and a panel of buttons.

The characteristic features of the apparatus and the crank device will appear from the attached independent claims, and further embodiments thereof will appear from the related sub-claims. Also, these and other features and related advantages of the present invention will be apparent from the attached drawings and description to follow.

Brief description of the drawings

The technical features of the invention, the wide range of exercise modes offered, and the inherent improvements over the prior art will be described with reference to accompanying drawings, which illustrates preferred embodiments of the invention by example and in which:

Figs. 1a - 1c show a side view, top view and a front view of an inventive crank device, respectively for use in an apparatus of the invention;

Fig. 2 shows a perspective view of the crank device shown in fig. 1;

Figs. 3a - 3d show a flywheel and drive assembly in side view, front view, and enlarged fractional front and perspective views;

Fig. 4 shows a perspective view of the flywheel and drive assembly;

Figs. 5a - 5b show alternative embodiments related to flywheel connection;

Figs. 6a - 6d illustrate motions of pedals provided through use of the crank device of present invention and the motions relative to available variations in dimensions;

Figs. 7a - 7h show the movement of crank arms during a full orbit;

Fig. 8 illustrates a first embodiment of working principle of the invention;

Figs. 9a and 9b illustrate second and third variants of the embodiment in fig. 8;

Fig. 10 shows a foot support capable of being forcibly held in a horizontal position through a full elliptic orbit;

Figs. 11a, 11b and 11c, 11d show schematically and as example first and second transmission embodiments related to position control mechanism for foot supports;

Figs. 12a and 12b show a side view and a front view, respectively, of another and further advanced crank device according to the invention;

Fig. 13 shows a perspective view of the embodiment shown in fig. 12 plus additional attachable cover;

Figs. 14a and 14b show exemplifying first and second means for lengthening of crank arms;

Figs. 15a and 15b show in side view and front view a solution to combine the technical aspects of the invention shown on figures 11 and 14;

Fig. 16 shows a block schematic of adjustable automatic stride control;

Figs. 17a - 17c show in top plan view, side view and front view a foot supporting platform with tilt motion;

Figs. 18a and 18b show a multi-mode pedal with provisions for either sideways tilt motion and conventional operational mode;

Fig. 19a – 19c show in operational side and perspective views, as well as collapsed view a training or exercise apparatus making use of the invention, provide with movable foot supporting platforms and operationally stationary handlebars;

Figs. 20a - 20c show a training/ exercise apparatus making use of the invention with movable foot supporting platforms and simultaneously movable handlebars;

Figs. 21a – 21c show in schematic front view, and first and second perspective views a crank device according to the invention as shown in fig. 12 with additional means for adjustment of path inclination;

Figs. 21d – 21e show in schematic front view, and first and second perspective views a modification of the embodiment shown in figs. 21a – 21c, the modification to enable a foot support always to stay horizontal throughout its movement cycle.

Figs. 22a – 22c show various stages of movement of crank arm and foot supporting platform related to the embodiment of figs. 12 and 13;

Figs. 23a – 23e show schematically preferred and available orbital and rectilinear movement paths for pedal and foot supporting platform;

Fig. 24 shows a block schematic of training/ exercise apparatus and system according to the invention for adjustment of orbital and rectilinear paths;

Figs. 25a - 25c show in front perspective, rear perspective and side views a training/ exercise apparatus with inventive crank device and movable handles;

Fig. 26 shows an exercise apparatus with a crank device;

Fig. 27 shows an exercise apparatus with path adjustable crank device and a reclining seat;

Figs. 28a and 28b show in front and side view a compact type of crank device according to the invention with inner gear transmission;

Fig. 29 is a perspective view of the compact type crank device according to fig. 28;

Figs. 30a and 30b show the motion of the compact type of crank device according to figs. 28 and 29;

Fig. 31 shows a side view of a practical embodiment of an exercise apparatus according to the present invention;

Figs. 32a and 32b show perspective views of training/ exercise apparatus shown in fig. 31;

Fig. 33 shows in top front perspective view from one side structural details of a crank device suitably usable in an apparatus as shown in fig. 31 and 32;

Fig. 34 shows a working principle used to give handlebars movement for a training/ exercise apparatus according to the invention;

Fig. 35 shows in an enlarged, fractional view details of handle bar mechanism suitable for use in an apparatus as shown in fig. 31 and 32;

Figs. 36a and 36a show in perspective view from one and the other side a functional half of yet another crank device, according to the invention, for use with an exercise apparatus of the invention, and fig. 36c shows a perspective view of the complete crank device;

Fig. 37 shows an end view of the crank device half shown in figs. 36a and 36b;

Fig. 38 shows an exploded view of a part of the crank device of figs. 36 and 37 with lever means for inclination adjustment of the crank device;

Fig. 39 shows an exploded view of an inner crank arm assembly of the crank device as shown in fig. 36 and 37;

Fig. 40 shows a perspective view of the inner crank arm assembly of the crank device as shown in fig. 39;

Fig. 41 shows in a perspective and partly disassembled view an outer crank arm assembly of the crank device as shown in fig. 36 and 37;

Figs. 42a and 42b show perspective views of the outer crank arm assembly of the crank device as shown in figs. 36 and 37, and further as shown in fig. 41;

Figs. 43a shows a front view of the outer crank assembly of figs. 36, 37, 41 and 42, and figs. 43b and 43c show sections XLIIIb – XLIIIb and XLIIIc and XLIIIc in fig. 43a;

Fig. 44 shows a section through the crank device as shown in figs. 36 and 37;

Fig. 45 shows a perspective view with cutaway section through the crank device as shown in figs. 36, 37 and 44;

Fig. 46 shows a top, rear perspective view of a modified foot supporting platform with sideways tilt function;

Figs. 47a - 47e show bottom, side and rear views, and longitudinal and transverse sections of the modified foot supporting platform as shown in fig 46;

Fig. 48a is a top plan view and fig. 48b is a perspective view shown with a transverse section of the foot supporting platform of fig 46, said platform for providing toe and heel movement;

Fig. 49 shows an exploded view of a mechanism for providing toe and heel motion of the platform as shown in fig. 48;

Fig. 50 shows a perspective view of an enlarged fractional part of the platform as shown in figs. 48 and 49;

Fig. 51 is a side view, partly shown in section of the platform as shown in figs. 48 to 50, and related to section LI-LI in fig. 52;

Fig. 52 shows a rear view of the platform with structural elements as shown in fig. 48 to 51;

Fig. 53 shows in an enlarged view detail the lower part shown in fig. 51;

Fig. 54 shows schematically tilting motion of the foot supporting platform to provide up and down motion of toe and heel;

Fig. 55 shows a block schematic of a man machine interface system (MMI) according to the present invention;

Fig. 56 shows schematically a further improvement according to the invention through an exercise apparatus a twin crank device mechanism;

Figs. 57a - 57b show schematically another two variant embodiments of a twin crank device operated training/ exercise apparatus;

Fig. 58 shows schematically yet another variant embodiment of a twin crank device operated training/exercise apparatus;

Fig. 59 shows schematically a further embodiment of a training/ exercise apparatus of the invention using a single crank device with linked bars;

Figs. 60a - 60c show schematically a further modified embodiment of a twin crank device operated training/ exercise apparatus with telescopic bars linking the crank devices.

Figs. 61a and 60b show perspective view and top view of training apparatus with motor.

Fig. 62 shows block schematic of system for training apparatus with motor.

Fig. 63 shows a perspective view of training apparatus with motor connected to flywheel.

Figs. 64a and 64b shows a schematic view of motor connection in training apparatus.

Fig. 65 shows block schematic of system for training apparatus shown in figs 63 and 64.

Detailed description of the invention

The following figs. 1-9 show a basic solution for creating cardanic motion. The basic theory being of prior art, the construction shown as an example of how to use such motion in an apparatus for physical training, exercise and any related therapy.

Figs. 1 and 2 show a crank device assembly according to the invention. On a frame 1 is mounted a crank assembly comprising a pair of crank arms 2 and 3 rotationally linked together at articulated joints and 5. Inner crank arms 6 and 7 are fixed together by means of an axle 8. Outer crank arms 10 and 11 are fixed through axles 12 and 13 to cog wheels 14 and 15 (see fig.2) to be rotationally mounted on the inner crank arms 6 and 7. It is specifically noted that the outer crank arms 10, 11 have a physical length, which under no circumstances will be less than the physical length of the inner crank arms 6, 7. In order to provide for a crank device that is compact and yet offers a highly satisfactory performance adapted to the requirements of an apparatus user, and with the possibility of adjusting the length of the outer crank arms to be equal to the length of the inner crank arms or more suitably exceed the length of the inner crank arms by a certain percentage, variations of path to be described by the pedals or supporting platforms can easily be made.

To the frame 1 is fixedly attached non-rotary cog wheels 16 and 17. A circumference ratio between cog wheels 16 and 14, as well as cog wheels 17 and 15 is 2:1. Chains 18 and 19 connects the cog wheels 14,16 and 15, 17. It should be understood that belt and pulley arrangement or a toothed belt and cog wheels could replace the chain and cog wheels approach. Further aspects of the embodiment of figs. 1 and 2 will be discussed in connection with figs. 6 – 9, figs. 9a and 9b showing structural variants which, however are functionally giving similar operation performance to an apparatus user. The end portions of the outer crank arms have foot supports, suitably in the form of pedals 20 and 21, but as disclosed below and shown in the drawings, e.g. on fig. 10, other means of foot supports such as platforms are preferred to use the full potential offered by this invention.

To the axle 8 is fixedly attached a wheel 22, which rotates when the crank device is set in motion. As shown in figs. 3-4 a wheel 24 runs on an inside perimeter of wheel 22. The wheel 24 is connected to a wheel 25 via an axle 26 extending through a tension block 27 fixed to the frame 1. The tensioning of the wheel 24 relative to wheel 22 is adjusted by screws 27’ on the tension block 27. A flywheel 30 is located freely rotatable

around the axle 8. A belt 31 connects the flywheel 30 to wheel 25. As the crank arms are set in motion the flywheel 30 is set in motion. The ratio between wheels 22 and 24 is in the area of 10:3 – 10:1, but can be varied depending on the size and wanted speed of the flywheel. The quoted ratio is therefore not in any way critical.

It is desirable to monitor the rotational speed of the flywheel or the crank wheels so as to measure the distance travelled by a user of the inventive apparatus and also to control the level of workout experienced by the user. The movement resistance and simulated distance may be co-ordinated with the workout level desired by the user, for instance, a desired heart rate range for optimum caloric expenditure. A heart rate monitor or other sensors may be utilised to sense the desired or required physical parameters to be optimised during exercise. Any standard method of measuring the speed of the flywheels may be utilised. For instance, an optical or magnetic strobe wheel or pattern may be mounted on a disk, or other rotating member, e.g. the wheel 22, of the present apparatus. An optical or magnetic sensor 28 may monitor the rotational speed of the strobe wheel 29 to generate an electrical signal related to such rotational speed and whereby such signal can be processed by a computer located e.g. on the apparatus. A man machine interface system (MMI) and device will be described below with reference to fig. 16, 24 and 55.

As shown in figs. 5a and 5b the flywheel 30 can also be located spaced from the crank assembly and wheels 22, 25. The apparatus of present invention includes a system for selectively applying the braking or retarding force on the rotation of the crank wheels through for example an eddy current brake system, such as indicated on fig. 4 by reference numeral 34. Such a brake system is known in the art and used on training/ exercise apparatus currently on the market. Other brake devices that could be used include using a belt running around the flywheel and provided with means for varying the tensioning, or by using conventional brake shoes interacting with the flywheel.

The possible motion of the crank arms is further shown in figs. 6 and 7. As shown in fig. 6 the result of one rotation of the inner crank arms 6, 7 will give an elliptic orbit 40 at positions of the pedals 20, 21. The length of the outer crank arm 10,11, or fixing point

41, 42 of the respective pedal decides the range (and size) of travel as shown on fig. 6b. When setting the pedals and crank arms in motion, as indicated by arrow 48 on fig. 7, the end of the outer crank arm 10, 11 rotationally linked to the inner arm 6, 7 will travel as indicated by arrow 49. This is a result of a rotating movement of the cog wheels 14, 15 fixedly attached to the respective inner crank arm 6, 7 and their travel along the chains revolving around the fixed cog wheels 16, 17, thereby defining a cardanic motion.

As shown in fig. 6, whether an elliptic or circular orbit or linear track will be described by the pedals when in motion will be the result of choice of the length ICAL of the inner crank arm 6, 7 between a) its centre of rotation and b) is point of rotation with the outer crank arm, se reference numeral 39 on fig. 6b, and the length OCAL of the outer crank arm 10, 11 between b) the point of rotation with the inner crank arm (se reference numeral 47) and c) the point of rotation with the pedal or supporting platform (se reference numerals 41, 42 or 43. Thus, as disclosed in fig. 6d and which is related to figs. 6a – 6c, PL is length of path (orbital or rectilinear) described by the pedal or supporting platform, i.e. the stride length, and PH is height of path (orbital or rectilinear).

The following equations (Eqs.1, 2 and 3) will determine the orbital paths, given that the circumferential ratio between cog wheels 16, 14 and 17,15 is as disclosed before, i.e. 2:1.

$$PL = 2 \times ICAL + 2 \times OCAL \qquad \text{Eq.1}$$
$$PH = 2 \times OCAL - 2 \times ICAL;\ \text{for } OCAL \text{ being } = \text{ or } > ICAL \qquad \text{Eq.2}$$
$$PH = 2 \times ICAL - 2 \times OCAL;\ \text{for } OCAL \text{ being } 0 \text{ or } < ICAL \qquad \text{Eq.3}$$

If OCAL = ICAL, i. e. the pedal is located at location 43, it is seen that PH = 0, i.e. that the pedal obtains a rectilinear path rather than an elliptic or circular path, and that PL will be 2 x (ICAL + OCAL).

If OCAL = 0, i.e. the pedal is located at location 47, then PL = PH and the path described by the pedal will be circular. This is however identical to an ordinary bicycle mode (circular mode), and not of particular importance in the present context. In fact, it is strongly preferred, according to the present invention that OCAL > ICAL.

If OCAL > ICAL, i.e. the pedal is located at location 41; 42, and Eqs. 1 and 2 apply, i.e. that PH < PL and an elliptical path is obtained.

If ICAL is 150 mm and OCAL is 175mm, we get PL = 2 x 150mm + 2 x 175mm = 650mm and PH = 2 x 175mm – 2 x 150mm = 50mm.

In the non-limiting example shown on figs. 6a – 6c it is seen that OCAL is approximately equal to 2 x ICAL. Thus, applying equations #1 and #2 above will yield: PL = 6 ICAL, and PH = 2 ICAL.

Placing pedals or platforms on the outer crank arm 10; 11 along lines 44 and 45 and holes 41- 42 gives them an elliptical orbital movement, except at point 43 where the pedals or platforms achieves a flat or rather rectilinear path 46. The path 46 is thus achieved when the distance between fixing point of the foot supports (e.g. pedal) and outer crank arm axle linking to the inner arm is identical to the distance 39 between outer crank arm axle linking to the inner crank arm and inner crank arm axle. Placing pedals or platforms at point 47 thus causes a circular movement to be achieved. The movement of the outer crank arms are shown in fig. 6c where reference numerals 43', 43" and 43'" indicates the centre point of crank arms 10; 11 in the upright, inclined (approx. 45°) and horizontal postures, respectively.

Adjustment of OCAL to be equal to ICAL can be utilised in a training/exercise apparatus for simulating a skiing motion.

The direction of the orbit the pedals perform when set in motion is also dependent on the ratio OCAL: ICAL.

When the outer crank arms are shorter than the inner crank arms, i.e. OCAL < ICAL, and when the outer crank arms are set in motion, the pedals will enter into an elliptical orbit in the same movement direction as that of the inner crank arms and axle.

When the outer crank arms are longer than the inner crank arms and which when outer crank arms are set in motion gives the pedals an elliptical orbit in the opposite direction of the inner crank arms and axle.

Thus, if OCAL > ICAL the pedals will describe an orbital path direction which will be in a direction opposite to direction of rotation of the main crank axle, and if OCAL < ICAL the pedals will describe an orbital path direction which will be in the same direction of rotation of the main crank axle.

It should be noted that preferred embodiments of the invention would demand that the outer crank arm 10; 11 is longer than the inner crank arm 6; 7. A stride length between 300 mm and 900 mm seems to be the range on which the dimensions OCAL and ICAL should be based. It will readily appreciated that the operating part forming the crank arm device assembly should easily fit with comfortable space clearance between the legs of a user. The size of the cog wheels or gears in the crank arm device solution as made according to any described embodiment of the invention is not a fixed matter as such, although the cog wheels or gears should be dimensioned to withstand the forces and weight applied by the user, the ratio between the gears 16, 14 and 17, 15 always being 2:1. Making a technical solution where the outer crank arms are shorter than the inner crank arms would demand an undesirable big sun gear 16, 17 to achieve optimal stride lengths, and such a solution should definitely be avoided in order to effectively reduce physical size of the sun gear, the related dimension and weight of the apparatus, and the extra cost of a large sun gear.

The figures 7a-7h show the travel of the crank arms at 45% intervals through a full 360 orbit. It should be noted that the rotation of the inner crank arm is opposite the rotation of outer crank arm. This rotational direction is dependent on that the outer crank arm is

longer than the inner crank arm or more correctly that the fixing point of the foot support is longer than the distance 39 between outer crank axle and inner crank axle. If the outer crank axle is shorter than the inner crank axle the motion of the foot supports will move in the same direction as the inner crank arm axle.
The invention is now to be further described with reference to figs. 8, 9a and 9b.
As previously disclosed, and now further illustrated on fig. 8, the first embodiment of the inventive crank arm device assembly uses a chain 50 to transfer to the outer crank arms 51 the desired motion. Fig. 8 shows a fixed cog wheel (sun gear) 52 and a rotary cog wheel 53 fixed to the outer crank arm 52 and which can be rotated relative to the inner crank arm 54. The motion can also be achieved by using gears directly connected as shown in fig. 9a or conical gears as illustrated in fig. 9b. Gear 60 is fixed and when moving the outer crank arm 61 as indicated by arrow 62, gear 63 fixed to the outer crank arm 61 rotates, and in turn rotates gear 64, which then revolves around the circumference of gear 61. Gears 60, 64 and 63 are in the diametrical ratios 2:1:1, and these gears are all in a rotary manner attached to the inner crank arm 65. Fig. 9b show gears 60 and 64 replaced by bevel gears 66, 67 and transmission gears 68, 68' interconnect by a common drive axle 69. The gears 66,67, 68 and 68' are all rotationally supported on the inner crank arm 65. The gear ratio between gears 65 and 67 should be 2:1. For the outer crank arm 61 to revolve 360 degrees and making an elliptical or linear path for the foot supporting means, the ratio between the inner gear and the outer gear must be 2:1.

Another aspect of the invention is to vary the motion and more specifically the orientation of the path of the foot supports, created by the crank device. Fig. 6a illustrates by dotted lines 38 how the orientation of the path is changed. This is however also explained regarding fig. 23.

For a preferred embodiment of the invention the cog wheel, or sun gear, earlier described as a fixed unit, is optionally rotational through a limited angular distance, i.e. from a fixed position to another fixed position. As illustrated with arrow 35 on fig 2, the cog wheel 16 can be rotated a desired number of degrees relative to the frame 1 and the crank arms 6,7 and 16, 17. A lever 36 is fixed to the cog wheel 16 (and thereby also to

cog wheel 17) and which when moved in direction of the arrow 37 turns the cog wheels 16 and 17 simultaneously. The lever may also be operated by motor assistance, as will be more closely described in regards to figs. 31, 36-38 and 45 below.

A training apparatus which to be used for simulating running, will demand foot supporting means in the form of platforms, and such platforms should be made to stay in a horizontal position or other wanted angle during a full rotation of the crank arms. Fig. 10 shows a platform 70 through a full orbit staying horizontal in all positions. As shown in fig. 11, an outer crank arm 75 has a first gear or cog wheel 77 attached to the pedal/ platform axle, said gear 77 being connected via a chain 76 to a second gear 78 attached to an outer crank arm axle 71. Gear 78 is connected through axle 71 to a gear 80 on the rear side of the outer and inner crank arms 75 and 79. Gear 80 is connected via a chain 85 to a gear 82, which is fixed to a frame 84. The ratio between the gears 77, 78, 80 and 82 is 1:1 as suggested in fig. 11a -b. This keeps the platform 70 at a same angle independent of the rotational positions of the crank arms. As shown in figs. 11 and 11d the chain drive 76 is replaced by an axle 90 with conical gears 91 and 92 at the ends thereof, gear 91 connecting with gear 96 on platform axle 94 and which provides for a 1:1 rotation to the platform axle 94 from gear 95 and via gear 92, axle 90, and gears 91, 96.

Figs. 12 and13 show a second and preferred embodiment within the scope of the invention, and which gives foot supporting means, such as platforms, a controlled angle relative to the horizontal through a 360° rotation of the crank arms. The solution gives the same general operations result as for the solution shown in fig. 11, but has two fixing positions for a platform. It should be noted that figs. 12 and 13 only show one side of the crank device and that the construction is similar on the other side of the frame 101.

As described for the embodiment shown in figs. 1 and 2 the crank device has an outer crank arm 100 rotational fixed to an inner crank arm 105. A cog wheel 103 is stationary fixed to the frame 101, and is operationally linked to cog wheel 102 through use of a chain 108. Cog wheel 102 is fixed to outer crank arm 100 via an axle 106 (shown by

dotted line) rotationally through inner crank arm 105. The ratio between cog wheel 103 and 102 is 2:1. As shown in fig. 7 movement of an outer crank arm will turn cog 102 and move the rotational joint 110 (which includes also axle 106) between the two crank arms 100 and 105, through use of the chain 108 extending around cog wheels 102 and 103, around the fixed cog 103. A cog wheel 112 is rotationally fixed to the outer crank arm 100, but stationary fixed to the inner crank arm 105 and thus fixed relative to cog wheel 102. Mutual movement of the crank arms 100, 105 will make cog wheel 112 rotate relative to the outer crank arm 100. This rotation is transferred to a cog wheel 114 rotationally linked to the outer crank arm 100 through use of a chain 115. The transmission ratio between wheels 112 and 114 is 1:2. Fixed in centre of cog wheel 114 is cog 120 with a fixing point 121 for attachment of platform. The rotation of cog 114 makes cog wheel 120 and a platform (not shown), which is fixedly attachable to fixing point 121, rotate independently of the crank arms 100 and 105.

It should be understood that the ratio shown in this embodiment is made for keeping a pedal or platform in one posture through a full 360 ° rotation of the cranks, and changing the ratios will angle the platform differently. A second fixing point 123 on the outer crank arm 100 for attachment of a platform is placed in the centre of a cog wheel 122 which is rotational relative to and supported by outer crank arm. Between cog wheels 120 and 122 is located a chain 124, which in ratio 1:1 transfers rotation from cog wheel 120 to cog wheel 122 and thereby to any attached platform attached at fixing point 123. This gives such a combined gear/ crank arm device two fixing points 121; 123 for platforms, fixing point 121 providing for a flat or rectilinear path for the platform, as indicated on fig. 23d.

As explained relative to fig. 6 a flat or rectilinear path is achieved when the distance between fixing point of the foot supports 121 and outer crank arm axle (forming rotational link with the inner crank arm) is identical to the distance between outer crank axle and inner crank axle (related to the end of the inner crank arm opposite to that related to said outer crank arm axle). Position 110 representing in part a rotational joint has a circular motion, but a fixing point for platform is not shown thereat, as such

circular motion is not a prime object as regards practical use of the crank arm device and the apparatus of the invention.

Fig. 13 shows in perspective the same crank device described above for fig. 12. Numerals 125 and 126 show screws for fitting a cover 127 over the cog-wheels and chains operatively attached to the outer crank arm 100.

In a training/exercise apparatus utilising the invention an adjustment of stride length is highly desirable. This can be done as explained above in connection with fig. 6, but methods of achieving this during operation of the apparatus will now be explained using assistance from that shown in fig. 14-16.

Fig. 14a show outer crank arms 130 and 131 with foot supporting means 132 and 133 attached to means for adjusting the length of the crank arms 130, 131 and thereby fixing point of the foot support. The means illustrated are fluid filled cylinders 134 and 135. Using pressurised fluid, e.g. oil, and return springs the cylinders can expand or retract, thus giving a variation of stride length 136. For a system like this, pumps for adjusting the fluid pressure is necessary and one pump on each arm connected to each cylinder is one solution as indicated by reference numeral 137. Sensors have to be included in the system for measuring the speed during rotation of the crank, said sensors coupled to means for signalling to a pump, whereby the oil pressure can be increased or reduced to give a stride dependent on speed. Short stride for low speed and long stride at high speed could be a preferred mode.

Fig. 14b illustrates variation of stride length through using treaded bolts 138 which when given a rotation moves the outer ends of the crank arms. As illustrated in fig. 14b, the bolts 138 and 139 can be fitted with electric motors 140 and 141, which can rotate the bolts when given the wanted signal. A sensor can be arranged to measure the speed of the crank arms and through a CPU 162 (shown on fig. 16) signalling the motors for executing wanted length of the outer crank arms. Power is supplied through contact rings and brushes at the axle positions as indicated by 141 and 142.

All mechanical, electrical and or fluid guide parts, as well as control means related to the principles of figs. 14a and 14b are not shown in detail, but is shown here for describing the outer crank arm extension and retraction possibilities as the pedals or platforms move along the intended path.

A preferred embodiment, according to the invention, of the crank arm device and related to the adjustment of crank arm length is shown on fig. 36-45 and described further below.

However, some further aspects of the invention related to how a crank arm can be made for both having controlled pedal angle and adjustment of crank arm length, is now to be described with reference to figs. 15a and 15b, showing a variant of the crank device as shown in figs. 11c and 11d. An outer crank arm 150 consists of two parts 151 and 152 which when slid relative to each other as indicated by arrow 153, adjusts the length of the crank arm. An axle 155 with gears as shown 156,157 and 158,159 similar to that shown in fig. 11 is telescopic and will adjust with the length of the crank.

The aim of the invention is to create a training or exercise apparatus where the dimension(s) of the orbital or rectilinear path of the foot supporting means are automatically adjustable depending on speed of crank rotation and of pedal travel. Setting of dimension(s) of the orbit for foot supports can be provided through use of a kind of man machine interface MMI device for user personal adjustments, resistance to work-out, advisor displays, updated results, suitably including a display with a keypad/buttons or a touch screen for input of user values.

Fig. 16 shows a schematic illustration of a system for automatic, or user defined motion or stride control and adjustment. Speed of the cranks can be measured by a sensor 160 for example directly operative on a crank axle, axle mounted wheel, flywheel or other parts rotating as result of crank axle rotation, denoted by reference numeral 161.

The sensor 160 sends signals to a microprocessor or CPU 162, which through a program signals means for adjusting cranks 163 and 164. Reference numerals 165 and 166

indicate motors or pumps. Sensors 167, 168 measure the length of the cranks. Means for operating is provided in form of button clusters with display or in the form of a touchscreen169. Run by a program in the CPU choices are displayed on a screen, for example user defined adjustment of the stride indicated and adjustable on a display170 or automatic adjustment of stride dependent on speed indicated and adjustable on display 171. Further explanation of the means for operating preferably called a man machine interface MMI device is found below in relation with fig. 24 and fig. 55.

The crank device will have means for supporting the foot of a user. Depending on the type of training apparatus the crank device is mounted in, either platforms or pedals are fixed to the crank arms. To gain proprioceptive training, the crank device should have mounted thereon multiple use platforms or pedals.

Fig. 17 shows a type of platform, which has means for causing tilting about a longitudinal axis thereof. An upper platform part 180 is fixed to a frame 181 through pivot axles 183 and 184. The frame has an axle or bolt 185 for fixing to an outer crank arm. As illustrated in fig. 17c the platform upper part can be tilted transverse to the axle 185. The platform upper part is lockable against tilting, if so desired, through rotating a bar 188 to be parallel to the axle 185, the bar having the same dimension as a gap between an underside face of the platform part 180 and the frame 181.

Fig. 18 shows a prior art pedal with tilt motion as the prior art found in WO00/68067 assigned Flexiped AS. The pedal body 190 has an axle 191 attachable to a crank arm (not shown). A footrest 192 is in a tiltable manner fixed at 90° to axle 191 of the pedal body. This gives a pedal with one traditional stable pedal face 193 and an unstable, sideways tiltable face 194.

As mentioned above the invention may be utilised in a number of embodiments of pedal or platform driven apparatus. Fig. 19 shows a training apparatus utilising the invention with platforms 200 and 201 and handles 203 and 204, which are stationary during operation. The crank device 205 shown is described according to fig. 12. However, it should be understood that any of the embodiments or variations thereof, shown in this

could be utilised in such an apparatus. The training apparatus shown is through use of the invention possible to make as a compact unit, and as shown on fig. 19c the handles 203, 204 are downward foldable, and the frame legs 206, 207 are foldable, and thereby saving space when in storage.

A main feature of the invention is the versatility in training motions and the users freedom of choosing preferred motions. The following will explain the inventions ability to do so, using the above explained features in combination with new embodiments.

Figs. 20a - 20c show a training/ exercise apparatus utilising the invention with platforms and moving handles 210, 211. The figures are purely schematic and show how prior art regarding moving handles can be incorporated with the crank arm devices according the invention. The handles 210 and 211 are hinged/ articulated to bars 212 and 213, respectively, said bars 212 and 213 being linked to the crank device through use of rotary axles located at the joint between the outer crank arm and the inner crank arm (se inter alia fig. 13). Details are not shown, as the principle should be obvious to any expert in the art and given the teachings of the present invention. It should be emphasised that the flywheel can be placed spaced apart from the crank device, as e.g. indicated on fig. 5, and be linked to the rotating crank axle through a belt or chain transmission. Fig. 20c illustrates how one can achieve an "uphill or downhill" training experience by changing the angle 215 of orbital path of the platform made possible by the inventive crank arm device. By adjusting the angle of the crank arm device 214 relative to the training/exercise apparatus frame, the elliptical orbit can be adjusted. The crank device is tiltable linked to the frame on an axle 215 and the incline is adjustable using a motor 216 with a threaded bolt 217 connected to the crank device.

As shown in fig. 20c the angle of the orbit and stride track can be adjusted by tilting the whole crank arm device relative to the frame of the training apparatus. This does however also tilt the fitted platforms. As will be shown in the following drawing figures the angle of the orbit and the orbital track can be adjusted relative to the frame of the

crank device and still keeping fitted platforms at a horizontal level, however without tilting the whole crank arm device.

Fig. 21a and 21b shows the embodiment related to figs. 12-13 where the stationary cog wheel 220 is adjustable. The cog wheel 220 is adjustably attached to the frame 222 in such a matter that it can be released from locking engagement with the frame 222, rotated and then fixed back to locking engagement with the frame. A rotation of the cog wheel 220, as indicated by arrow 224, will make cog wheel 223 turn and move the outer crank arm 228 as indicated by arrow 225. However, the platform fixing points 230 and 231 will turn slightly from their original oriented position, and crank arm 232 still is still rotably attached to cog wheel 220, but remains stationary during angular setting of the cog wheel 220. The platform fixing point 230 when used gives an elliptical path, and the fixing point 231 when used gives a flat or rectilinear path of movement of the platform. Cog wheel 220 is after being turned fastened relative to the frame 222 and the further motion of the crank arms 228 and 232 will then work as explained earlier, but with the path or orbit of the motion of the platforms at an offset angle relative to a horizontal plane. To further explain, the cog wheel 220 is rotated a given degree as indicated by arrow 233, relative to the frame 222 and inner crank arm 232 illustrated with reference point 234. This may be done by a lever 229 fixed relative to the cog wheel 220, which can be assisted by a motor and treaded bolt, worm gear or other gearing means or as shown below in fig. 36-38. The cog wheel 220 may also be directly connected to a motor 227 (suitably including a locking gear) as indicated on fig. 21a.

Figs. 21d – 21f show a modification of the embodiment of figs. 21a – 21c to provide for the platform fixing points 230 and 231 to stay in the original oriented position. The modification exhibits an inner cog wheel 220' which remains fixed to the frame, and crank arm 232 still is rotatable relative to cog wheel 220, as mentioned above, but is kept stationary during angular setting of cog wheel 220. The cog wheel 220' is engaged with cog wheel 223' by means of a chain and the cog wheel 223' is fixed relative to cog wheel 237. The cog wheel 237 holds cog wheel 238 and the platform fixing points 230 and 231 in position through a revolution of the crank. The ratio between inner cog wheel 220' and the cog wheels positioning the platforms are 1:1, though the ratio

between cog wheels 220' and 223' is shown 2:1, and the ratio between cog wheels 237 and 238 is 1:2, which result in a ratio of 1:1 between the platforms and frame.

Fig. 22 shows a platform 236 connected to the outer crank arm outer fixing point 231, see fig. 21c. Fig. 22a shows a folded position of the crank arms. A 45° rotation of the crank arms relative to gear 220 is shown in fig. 22b, and another 45° rotation of the crank arms is shown in fig. 22c. The platform 236 will stay in the same position relative to the frame through a full rotation as explained in relation to figures 11-13.
Fig. 23a shows different orbits and paths possible from using the crank device according to the invention explained above, 250 indicating orbits, and 251 indicating a straight or rectilinear path motion. The orbit and size of paths is explained with reference to fig. 6. Fig. 23b show orbit of platforms 254 remaining in a horizontal orientation whilst fig. 23c show the orbit of the platforms at an angle relative to a horizontal plane. Fig. 23d show also orbit at an angle relative to a horizontal plane but note the upward movement orientation of the platforms, although the platforms remain in a horizontal posture, which when used in a training/exercise apparatus will give a climb or step sensation for the user. Fig. 23e show platforms oriented along a line which gives a skiing simulation used in a training machine. All orientations shown in figures 23a – 23e can be achieved in one training apparatus when utilising the invention according to the embodiment explained relative to figs. 21-22.

Turning back to fig 21, there is indicated by number 227 an adjustment device, preferably a servo motor, which when activated can turn the gear 220 to fix the desired angle of the orbit or path. Having such an automated adjustment device incorporated in the crank arm device, a user is able to adjust the angle of stride when using a training apparatus utilizing the invention.

Fig. 24 shows schematically the main components of an automated adjustment system in a training apparatus, which when combining with a system as shown and explained with fig. 16, will give a user full control of the orbit size and stride length and angle, during a workout. A mechanical working adjustment device, e.g. an electric servomotor 260, used as an example in this embodiment, is connected to a fixed gear 262 like gear

220. A sensor 263 will monitor the movement of the motor or gear 262 and give signals to a CPU 264 which in turn is connected with a control device 265 or man machine interface device (MMI-unit) having screen, touch screen or display 266 with user means 267 for input and control. The CPU is programmed to show the adjustments made by the user on the screen/display. The adjustments made or chosen by the user from the control device is processed by the CPU which signals a motor controller 270 which sends the correct signals and power to the motors for turning gear and setting of cranks 271, 272 accordingly.

Fig. 25 shows a training apparatus utilising the invention. The training apparatus has handles 280 and 281, which are articulated to rods 282 and 283. The rods 282 and 283 are connected with the crank arm device between the two crank arm constructions, the pivotable connection 287 to the crank being eccentric and similar to the solution disclosed below on fig. 31. The handles move back and forth as indicated by arrow 285, and transverse with the platform movement, as one would do when skiing and which is a typical movement on prior art or cross-trainers. Reference numeral 286 shows a MMI unit as described above.

Fig. 26 shows a crank device 290 utilised in a training machine of an ergometer type or indoor training bicycle, the crank device being of any type described above and having a solution for changing the angle of path and orbit as shown in figs. 20-24 and solutions elaborated below relative to figs. 31-45.

Fig. 27 shows a crank device 292 utilised in a training machine of a recliner seat ergometer type and having the same functions as mentioned above in relation to fig. 26.

The crank device according to the invention may work with gears/cogs, connected with chains/belts, or directly geared.

Figs. 28 and 29 show a further and variant embodiment of the invention where the outer crank arms 308, 309 are fixed to gears 302 and 303, respectively that are directly connected to gears 304 and 305 which are toothed on the inside. These gears 304, 305

are preferable fixed to the apparatus frame, but may have means to rotate, as shown on figs. 2 and 21 to make a variety of the path and motion of the foot supports. Reference numerals 306 and 307 are the inner crank arms, and 308 and 309 are – as mentioned - the outer crank arms. The orbital path of the pedals 300 through movement of the crank arms is the same as shown for the embodiments shown in figs. 1-9. 298 denotes a possible location for flywheel or a drive gear or cog wheel, which will be fixed to the main crank axle when utilised on a training apparatus. An important aspect of the embodiment shown on figs.28 and 29 is that the outer crank arms have a length, which is substantially longer than that of the inner crank arms. Thus, equations #1 and #2 related to the discussion of fig. 6 apply for the present embodiment. It is seen from the embodiment shown on figs. 28a and 28b that OCAL is approx. 1.5 x ICAL, thus yielding an elliptical path where PL = 5 x ICAL and PH = 1 x ICAL. In the embodiment of fig. 30 OCAL = 4.5 x ICAL, yielding PL = 11 x ICAL and PH = 7 x ICAL. Thus, figs. 30a and 30b show that when foot support and outer crank arm 310 is moved in direction of arrow 311, the inner crank arm 312 will move counter-wise indicated by arrow 313 as the movable gear 314 moves on stationary gear 315.

It should be noted that preferred embodiments of the invention will demand that the outer crank arm 308, 310; 310 is longer than the inner crank arm 306, 306; 312. As indicated in relation to fig. 6, a stride length between 300 mm and 900 mm seems to be the range on which the dimensions OCAL and ICAL should be based. It will readily appreciated that the operating part forming the crank arm device assembly should easily fit with comfortable space clearance between the legs of a user. Therefore the size of the stationary gear 304, 305; 315 should at a minimum, also to reduce cost. Accordingly, the size of the cog wheel 302, 303; 314 or gear 304, 305; 315 the crank arm device should be dimensioned to withstand the forces and weight applied by the user, the ratio between the gears 304, 302; 305, 303; 315, 314 always being 2:1. Making a technical solution where the outer crank arms are shorter or almost of same length as the inner crank arms would demand an undesirable big and thus unacceptable stationary sun gear 304, 305; 315 to achieve optimal stride lengths, and such a solution should definitely be avoided in order to effectively reduce physical size of the sun gear, the related dimension and weight of the apparatus, and the extra cost of a large sun gear.

The following will describe a further embodiment showing an utilisation of the present invention.

Figs. 31 - 35 show a training apparatus 320 which has a crank arm device 322 which in principle works as crank arm device explained with reference to figs. 12 - 13 and figs. 21 – 22, the crank device having foot supporting means 321 and 325 which are held in a stable posture during rotation of the crank arms. The crank arm device also has a mechanism 375 for adjusting the angle of orbital or rectilinear path relative to the horizontal, e.g. as also illustrated in figs. 20 and 23.

The crank arm mechanism does not use cog wheels with chains as shown in earlier embodiments, but uses gears. The crank arm mechanism will be particularly described with reference to fig. 33. It will be readily understood that the outer and inner crank arms 341 and 331 have on the other side of the assembly shown similar elements, e.g. outer crank arm 340 with related inner crank arm 330. The inner crank arms 330 and 331 have gears 332 and 333, which revolve around sun gears 336 and 337 and drives gears 334 and 335 that are connected to the outer crank arms 340 and 341. The ratio between gears 336, 337 and 334, 335 is 2:1. The outer crank arms 340, 341 have gears 342 and 343, which are in fixed relation to the respective inner crank arm 330, 331. Gears 344 and 345, which are rotationally attached to the outer crank arms 340, 341 revolve around gears 342 and 343, respectively in connection with respective gears 346 and 347. The foot supporting means 321 and 325 are attachable to respective gears 346, 347 via axles 348 and 349. An axle 350 connects the inner crank arms 330, 331 through the sun gears 336, 337. A wheel 351 is fixed to the axle 350 and works as a pulley with a belt 352 connected with pulley 353 on flywheel 354. The flywheel has means of resistance in a manner as previously described, for example using an eddy current brake system, a magnet here indicated at 355.

The crank device is set in motion when the user forces the platforms downwards. Whilst the outer crank arms 340, 341 rotate in the direction of the platforms, the inner crank arms 330, 331 rotate counter-wise. Explaining from one side of the training apparatus;

the gear 347 is given a rotation relative to the outer crank arm, which is controlled by the motion of inner crank arm through gear 343 and gear 345. The ratio between gears 343 and 347 is 1:2.

The training apparatus has handlebars 360 and 361 tiltable relative to the frame and linked to the crank device. A disc 362 is arranged off-centre to the crank device main axle 350 to provide an eccentric arrangement. A ring member 363 on a bar 363' is rotatably placed round the disc 362. A rotation of the crank axle will make the disc 362 rotate and give a pulsating action to the bar 363' which is hinged to a rod 364. The rod 364 has transverse axle piece 365 forming a link via two bar pieces 366 and 367 to the handlebars. The motion of the ring member 362 and bar 363' makes the rod 364 move forward and backwards as indicated by arrow 368 and the movement is transferred to tilting motions of the handlebars 361 and 360, indicated by arrow 369.

The training apparatus according to a preferred embodiment of the invention can be provided with an adjustable mechanism, preferably automatically operated, for the variety of motions that can be provided by the invention. On the training apparatus shown in fig. 31-35, the sun gears 336, 337 are attached to levers 370 and 371. The levers are rotational around main crank axle 350. The levers 370 and 371 are joined by means of a cross-piece 373. A threaded bolt 374 runs through the cross-piece and holds the levers 370, 371 in position. Turning the bolt about its longitudinal axis will move the end of the levers along the length of the bolt 374 and turn the sun gears 336, 337 relative to the frame 324 (see fig. 31). The effect of changing the angle of the orbital or rectilinear path relative to the frame is generally as also explained in connection with figs. 21 - 23. The bolt 374 is on the training apparatus fixed to an electric motor 375, which a user can activate to change the motion of the apparatus.

The apparatus will also have a man machine interface device as explained above regarding fig. 24 and as indicated by number 323 on fig. 32a.

Fig. 32b shows an additional feature, which softens the motion of the training apparatus and gives the apparatus a tilting motion 326. Spring loaded feet 327 – 327'''' are fixed

to the frame of the apparatus. A rounded 328 section is located under the middle of the frame in the length of the apparatus.

A training apparatus of this kind can also include a weight monitoring application within the system. This requires the training apparatus having weight scale technology means built in to the training apparatus. A weight measuring system can be put in relation to the frame and floor. Viewing back on fig. 32b weight sensors may be fitted in cylinders 327 - 327''', the rounded section 328 should not be present when weight monitoring means 327 – 327''' are present. The part of frame 324' which supports the main crank axle 350 could be made telescopic with weight sensors if tilt function of the frame is desirable. A weight measuring system can also be fitted directly to the platforms 321 and 325 of the apparatus. This would however demand circular slide contacts at the crank arm joints to transfer signals through the apparatus to link up with a MMI system and a display. The MMI system would show the weight of a person on a display 323 and the user may monitor the progress of weight loss during training in a specific training session or in the course of a plurality of training sessions.

As described earlier together with figures 14-16 an adjustment of the elliptical orbit and the stride length for the crank device is desirable, especially when used in a training apparatus.

Figs. 36 –45 only show the basic mechanical elements of the training apparatus, but it should be understood that the apparatus may have another design and style than that e.g. shown on figs. 19, 20, 25, 26, 27, 31, 32 as regards e.g. the frame and will have covers to protect the user from the moving mechanical elements.

Figs. 36 - 45 elaborate a solution of how to control the angle of the foot supporting means and at the same time making it possible to vary the position of the foot supports along the length of the outer crank arms. This solution is shown in detail as to how the crank device for use in a training apparatus will give the user a variety of possible motions by simply using the MMI system as described relative to fig. 16 and 24 to control settings on the apparatus. Figs. 36a and 36b show perspective views of the one

side of yet another embodiment of the crank device whilst fig. 36c shows a perspective view of such crank arm device having both crank arms connected. Figs. 36-45 will thus focus on showing one of the two crank arms with connection to the centre crank axle and also showing a solution for the adjustment of angle or incline of motion which affects both crank arms.

Figs. 36a - 36c show frame part 324' which will be connected or part of a frame 324 in a training apparatus as shown for example on fig. 31. On the frame there is a main crank axle 360 connecting the two inner crank arms of which only arm 372 (formed by 372' and 372") is shown on the drawing figures. To the inner crank arms 372 there is rotationally attached outer crank arms 361 and 368 shown covered by respective covers. Circular plates 376 and 377 are fixed to the inner crank arms 372 and follow the rotational motion of the crank around the main crank axle 360. The outer crank arms are fixed to the inner crank arms similar to what is shown and described relative to figs. 31-33 and has the motion according to the invention as shown in figs. 6,7 and 23. A lever 378, similar in operation to levers 370 and 371 previously described is fixedly attached to the sun gear 386 of each inner crank arm 372, as will be described in more detail in the following figs. 37-45 and works generally as shown in the above figs. 21-23 and 31 and 33.

Position of the crank arms as shown in fig. 36 will give the foot supporting means a linear motion, when fixed to the outer crank arms at location 379 and 380 thereon. The outer crank arms 361, 368 have means available to enable shifting of the fixing points for the foot supports in order to vary the motion in a manner indicated above relative to figs. 14-15.

Fig. 37 shows a view of the crank device transverse crank axle 360 orientation, showing only one half of the crank arm construction. The sun gear 386 is located a round the main crank axle 360 and is fixedly attached relative to the frame through lever 378. A second gear 387 is in connection with the sun gear 386. A third gear 388 is in connection with gear 387, the gear 388 being fixedly attached to the outer crank arm 368. Motion applied to the outer crank arm 368 will force a rotational motion to the gear

388 and further a rotational motion of gear 387 which will revolve around sun gear 386, making inner crank arm 372 revolve and cause main crank axle 360 to rotate. On the figure there are shown a second set of gears 392,393 and 394 which are in connection with the outer crank arm 386 for adjusting the foot support fixing point 379 on arm 386 and, which is actuated by a gear 395 and worm gear 396, explained in greater detail below. As shown on above fig. 33 the main crank axle 350 has means 362, 363 for driving the movement of handlebars on a training apparatus. On fig. 39 is shown a disc 400 having an offset hole, the disc thus being fixedly attached offset to the inner crank arm member 372" around the axle 360 so to transfer a crank motion to bars linked to handle bars of a training apparatus, the construction shown in principle detail in figs. 33 and 35.

The sun gear 386 is fixed to a lever 378, through a boss 403 shown on figs. 38 and 39. The lever 378 holds the sun gear 386 in selected position assisted by a motor through a threaded bolt as shown for the similar function on figs. 31 and 33. Fig. 38 also shows the actuator for the positioning of outer foot supports. A worm gear 396 is in connection with gear 395, which in turn is fixed through a boss 406 with gear 392. The axle 360 runs through the parts shown in fig. 38 and moves individually on bearings 410 and 411 and is fixedly attached to the inner crank arm frame 372', as seen on fig 39. Fig. 39 shows the inner crank arm in exploded view. The gears 386, 387 and 388 are supported by bearings and bosses so as to turn individually relative to the gears 392, 393 and 394. Gears 386 and 387 are in ratio 2:1 to gear 388 and whereas gears 392 and 393 are in ratio 2:1 relative to gear 394.

As shown on figs. 39-45 an axle 414 is fixed to the inner crank arm frame 372''and protrudes through gears 394 and 388. Gear 388 is fixed to the outer crank arm frame 390', at protruding part 388' of the gear. It also seen that gear 394 has a protruding part 394' rotatable relative to gear 388 and extending through the gear 388 and its part 388'.

Shown on fig. 41 is the outer crank arm 368 without the cover as shown in fig. 36. The gear 394 is fixedly attached to a gear 420 which drives worm gears 421 and 422, the worm gears being fixed to or forming part of threaded bolts 423 and 424 and which

engage threaded holes in a cross piece 415 which is attached to an arm piece 416, said piece 416 being slidable relative to outer crank arm frame 390. A gear 426 is fixed to an axle 414, the gear 426 being in co-operative engagement with two worm gears 427 and 428. The worm gears 427, 428 extend through a supporting member or worm base 417 and are connected to telescopic rods 429 and 430, which are threaded 429', 430' at the other end for engagement with gear 434, the gear 434 having a hole 379 which is intended for engagement with a foot supporting platform.

Fig. 42a shows the outer crank arm in the position as shown in fig 36, giving a linear path for the foot support. The arm piece 416, which is fixed to the piece 415, is pulled together with worm base 417. Movement of the gear 420 turns the worm gears 421 and 422, which in turn causes the arm piece 416 to slide guided by tracks in side supports 431 and 432.

Fig. 43a - 43c show sections XLIIIb-XLIIIb and XLIIIc-XLIIIc, where further details of the outer crank arm construction is revealed and with the arm in an extended position.

Fig. 44 shows a section of the middle and centre of the crank arm construction, and show in detail how the different parts are connected. Outer crank arm frame part 390' is connected to gear 388 which is in contact with gear 387 which in turn is in contact with sun gear 386, the sun gear 386 being rigidly connected to lever 378. Inner crank arm frame part 372' is fixed to main axle 360 which extends through the sun gear 386. A second axle 414 is fixedly attached to the inner crank arm frame part 372'', the outer crank arm 368, 390 thus capable of revolving around axle 414. The axle 414 protrudes through the outer crank arm frame 390 and is attached to gear 426. As mentioned above, the gear 426 is connected to gears 427, 428 and rods 429, 430 keeping the posture or orientation of the foot support fixing point 379 steady through use of a 1:1 ratio relative to the frame. A gear 420 is also located around axle 414, but is fixed relative to gear 394, which connects with gear 393 and which again connects with gear 392. Gear 392 is connected with gear 395 which may be turned by bolt and worm gear 396. The movement of the gear is transferred to gear 420, which is connected with gears 421 and 422. As mentioned above gears 421 and 422 through use of threaded bolts 423 and 424

cause arm piece 416 to slide. Bolt 396 is on a training apparatus fixed to the frame 324' and by turning the bolt manually or preferably by means of a motor (not shown), adjustment of the foot support fixing point 379 along the outer crank arm is made possible. The threaded bolt 396 shown on fig. 45 is by means of its guiding means 425 – 425'' fixed to the frame 324'. Fig. 45 shows in perspective a cutaway section of the crank device one side according to the invention, without the frame or the circular plates 376 and 377.

Fig. 45 shows more clearly than the previous drawing figures all bearings for the gears, the bearings all denoted by the general reference 450.

As previously described above regarding figs. 17 and 18 a desirable feature of the foot supporting means is to have a tilting motion to the foot to achieve proprioceptive training, the foot supports preferably having means for locking this function.

Figs. 46 and 47 show a platform 460 fixed to a frame 461, the frame being tiltable and fixedly attached on an axle 462 to a body 463. The body has a lever 464 tiltable about the axle 462. The frame has a curved track 465 on each side of the body, the body having a track 466 radial to the curved track. A bolt 467 runs through and in the tracks. At an uplifted position of the lever 470, the bolt is forced into the radial track 466 by a spring 468 and the platform is locked. In a downward position the bolt is forced by the lever into the curved track 465 where the platform is free to tilt within the length of the track.

One of the main objects of the invention is to control the level of the foot supporting means. The above description has shown how to keep the platform at a static level throughout a revolving motion of the crank device. Further embodiment of the invention is achieving a motion where a toe and heel motion is achieved at each "end" positions of a path and motion.

Fig. 48 - 53 show a platform 460 which is to be attached to the outer crank arms of the crank devices with platform level control as shown in fig. 10-13, 19-25, 31-33, 36-45.

The tilt motion with a lever to lock the tilt function is substantially the same as shown on fig. 46. The platform is fixed to the crank device with bolt 480 attached to the level control of a crank arm, for example 380 as shown on fig. 10, 25 or fig. 36. The platform is optionally tiltable and is fixed to body 482. The body 482 compared to body 463 above, has a second axle 483, which holds a second body 484 having a cylindrical portion. The bolt 480 runs inside the cylindrical portion of the body 484 and is fixedly attached at end portion 485. A cylinder 486 is located on bearings 487-487' inside the cylindrical portion of the second body 484, the bolt 480 extending through it. Cylinder 486 has a boss member 488, which fixes the cylinder relative to the outer crank arm frame 390 of the crank device. An off-centre ring 489 is located around the cylinder 486, the ring 489 being located inside a circular hollow part 490 of body 482. A peg 491 (see fig. 53) and spring 492 is located inside the hollow part, which are in contact with the outside of ring 489. As learned from the above description the bolt 480 holds the platform at a stable level throughout a revolution of the crank device. The cylinder 486 being fixed to the outer crank arm frame 390 will create a rotation of the ring 489, which in turn forces the body 482 into a rocking motion from contact with said peg 491 and spring 492. As shown on fig. 54, the ring orientation is set so that through a rotation of the crank a tilt upwards of a toe end 494 of the platform 460 is created at the most forward position 496 of the path 497 of the platforms and a tilt upwards of the heel end 495 of the platform is created at the rear position 498 of the platform's path.

The crank device as shown in figures 36-45 is as mentioned to be fixed in a frame on a training apparatus in similar matter to what is shown in figs. 31-35. The apparatus will have means for the user to automatically adjust the fixing points for the foot supporting means, and the inclination of the crank arms.

As shown in fig. 16 and 24 the apparatus will have a man machine interface (MMI) system for the user. It should be apparent from the above described that on a screen, for example a touch screen, as part of the apparatus of present invention, a menu system and layout of choices and adjustments would at least show;

- paths of motion or style of training as: walking, running, climbing or skiing;

- individual adjustment of stride length, angle of path;
- level of resistance and other prior art adjustments regarding workout levels, caloric burn rates, heart rates/pulse etc....

Fig. 55 shows schematically how the MMI system would work. The screen on the training apparatus would show the different training options available. It may be a list 500 of icons, which represents the options. The list of options presented to the user may comprise a list of pre-programmed motions 501, such as: walk, jog, run, climb and ski, or options to enter user-defined motions. If a user selects "jog", the computer within the apparatus will run the "jog program" 503 and set the crank arms so that the foot supports will describe an elliptical path typical for a jogging motion. The system would preferably have included in the program an option 504 to enter personal data, as height, weight, physical shape and sex. The system will activate the means for adjusting the platform position along the crank arms 505 for making the correct path and path size based on the program and personal data. The system could also adjust the inclination of crank 506 according to the program and data. The system may adjust the resistance made to the flywheel based on personal data 507, or the user may override this and set the resistance manually 508. The system may also include a program for terrain 509, for example jogging on flat surface, or jogging on uneven terrain with hills for jogging uphill and downhill. The system would during such a program change the inclination during the workout session. Another function of such a system is to monitor the rate 511 of revolutions and the system will be able to activate the means for adjusting the platform position for making the correct size relevant to the speed. This means that if the user starts with a walking motion and speeds up the turning of movable parts of the crank device, the system will change and increase the stride length to be more appropriate towards for example running. The system would suitably include means for entry of user-defined motions 502, where the user may define the inclination 506 and path configuration 505 of the foot supports, and resistance 508 against movement, e.g. to simulate movement uphill. The amount of resistance applied may alternatively or in addition also be connected to a system monitoring the pulse rate and heart performance of the user, as known from prior art within the fitness industry 510 and for medical testing of an suspected heart condition.

Fig. 56 shows schematically a training apparatus with two crank devices 520 and 521 according to the invention. The outer crank arms 524, 524' and 525, 525' of the crank devices are linked together with bars 522 and 523, respectively, said bars 522, 523 serving as base for foot supporting means. The foot supports keep the same horizontal level through a revolution of the cranks.

Fig. 57a show schematically a training apparatus with a crank device 526 according to the invention and a conventional crank wheel 527, the cranks connected together by means for coordinating the rotational motion, as for example a belt or chain 530. The crank device 526 has its outer crank arms 531, 532 is linked to bars 528 and 529, which serves as base for foot supporting means. The bars 528, 529 are slidably connected to crank 527 through use of respective guide pins 533, 534. The foot supports keeps the same horizontal level through a revolution of the cranks 526, 527.

Fig. 57b shows a variant of the apparatus shown in fig. 57a where the conventional crank is labelled 527' and has a smaller diameter than the crank 527 of fig. 57a. Otherwise, the elements included are the same, however the guide pins now labelled as 533' and 534'. This provides an inclination of the foot supports during a revolution of the cranks, simulating a kind of toe and heel tilt close to a natural walking motion.

Fig. 58 shows schematically a training apparatus with a crank device 540 according to the invention and a conventional crank wheel 541, the cranks being connected together by means for co-ordinating the rotational motion, as for example a belt or chain 542 or gears. The crank device 540 is linked to bars 543 and 544, which serve as base for foot supporting means. The bars 543, 544 are slidably connected to foot supports 545 and 546, said foot supports 545, 546 in an articulated manner being linked to crank arms 549, 550, respectively. The foot supports 545, 546 keep the same horizontal posture through a full revolution of the cranks. The bars 543, 544 are optionally adjustable as regards fixing point 547 and 548, pins 553, 554 being provided for articulated joins between rear of bars 543, 544 and crank 541 at selected fixing points. The training apparatus has handlebars 551 and 552 tiltably mounted at location 555 to a frame

upright of the apparatus and in articulated slide-shoe 557, 558 engagement with a front end of bars 543, 544.

Fig. 59 shows a variation of what is shown on fig. 58, where the bars 543, 544 are attached in articulated manner to a pivot axle 559. Preferably the axle is vertically adjustable as indicated by 559', for adjusting the inclination and movement of the foot support.

Fig. 60a and 60b show schematically a training apparatus with a crank device 560 having inner crank arms 561, 561' and outer crank arms 562, 562' according to the invention, and a conventional crank wheel 563, the cranks 560, 563 connected together by means for co-ordinating the rotational motion, as for example a belt or chain 564. The crank device 560 is linked to telescopic bars 565 and 566, which serve as base for foot supporting means 567 and 568. The telescopic bars 563, 564 are linked at a front end to the outer crank arms 562, 562' via pivots and at the rear end to the crank wheel via pivots 570, 570'. Fig. 60a and 60b show both sides of the training apparatus where it shows how the telescopic bars are extended and compressed. Fig. 60c show another scenario of the embodiment in figs. 60 and 60b during a revolution of the cranks.

Other aspects of the invention regarding driving and braking force of the crank will now be explained with reference to figs. 61a and 61b, and figs. 64a and 64d. There is a demand for a training apparatus, which provides for smooth and easy motion of the body without the user having to use force to drive the apparatus, but only move legs and arms in order to follow a set motion and pace of the apparatus. This kind of apparatus is not intended to provide a braking force for the user to work against, as the motion of the apparatus forcibly makes the user move legs and arms at desired speed, in the fashion of a treadmill.

Figs. 61a and 61b show a training apparatus with crank arm device 600 similar to the apparatus and crank arm device 322 shown and described in figs. 31 and 32 above. Handlebars 601 and 602 are linked to a crank device in the fashion shown in figs. 31-35. The apparatus shown in fig. 61 does not have a flywheel. The crank device is connected to an electric motor 604 through use of a gearbox 605. A first pulley 607 is

operated by the gearbox 605, and the pulley 607 is connected with a second pulley 608 on a crank axle 609 by means of a belt 610. The motor 604 has power supply means (not shown on figs. 61a and 61b) and means for an apparatus user to control the speed of the motor. Fig. 62 provides a simplified block schematic indicating the crank arm device 600 connected to the motor 604. The motor 604 is powered a power supply 612 being a connection to the mains or a connection to a battery. An activator 613 or a CPU (computer and/or programmed controllers) is controlled by a unit 614 formed by a switch, a control panel and a display means or formed a touch screen for user monitoring and input, also referred to as an MMI system as described above. Preferably, a sensor 615 forms part of the system and signals to the CPU or activator 613 the speed of any rotating part of the crank device. The MMI system provides the user of all the information needed to monitor and set the speed of the apparatus.

It is also possible to use an electric motor for creating resistance and braking means on an embodiment of the apparatus according to the invention. Fig. 63 shows the training apparatus shown in fig. 32, with the addition of an electric motor 620 operatively connected to the flywheel 621. The motor is either connected to the flywheel directly by gear 622 as indicated on fig. 64a or by pulley and belt 624 shown on fig. 64b. In an electric DC motor it is possible to change the current so that the motor either can drive the crank arms or provide a resistance to movement of the crank arms when forcibly moved by a user. To have this double function the flywheel is needed for keeping a momentum when the motor is not driving the crank. Fig. 65 shows a block schematic of how such a system would be. A user is able to select between a forced drive mode 625 or a movement resistance mode 626. The CPU 613 activates delivery of power 612 to the motor 620 which will drive the crank device if forced drive mode 625 is selected. If movement resistance mode 626 is selected the current setting of the power in the motor will cause the drive direction of the crank device to be in reverse direction so as to give a movement resistance when crank is turned.

In the descriptive portion and the following claims foot supporting means or foot supports should be understood as applying to all kinds of pedals, pedal like devices,

platforms and other devices for apparatus made for placing feet and stepping on or otherwise moving the feet for turning a crank like device.

The invention described can be subject to modification and variations without thereby departing from the scope of the inventive concept as disclosed with reference to the drawings and further stated in the attached claims. To the extent that certain functional elements can be replaced by other elements to enable the same function to be performed by the various embodiments disclosed, such technical equivalents are included within the scope of the invention.